REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested.

In response to the Examiner's request for information about possibly related patents/applications that might be material to a double patenting rejection, the applicant notes that there is another copending application with overlapping inventorship that deals with image processing. That possibly related application is Serial No. 10/221,780 being examined by Examiner Trang U. Tran in Group Art Unit 2614. However, such is not believed to give rise to any double patenting concerns.

The Examiner is thanked for noting that current USPTO records do not acknowledge receipt of applicant's European priority document 99304824.8. The undersigned assumes that such was filed during the International stage of this application. It is also not now known if there is any difference in substance between this and the UK priority document filed 12 February 1999. Since it appears that the claims presently pending are entitled to at least the 12 February 1999 priority data for which priority has been perfected, it appears possibly irrelevant even if the EP priority document is missing.

In view of the formality-based objections, the entire application has been reviewed and amended above so as to put it into more traditional US format.

All outstanding grounds of rejection are based either solely or primarily upon Rix et al., a publication which includes as authors the two presently named inventors. Such

outstanding grounds of rejection are all respectfully traversed -- for at least the reason that Rix et al. does not constitute "prior art" to this application.

Although the Rix et al. article does bear the printed date "January 1999", this issue of the BT Technology Journal (which is published by the applicant assignee), was not actually published until 19 March 1999 (the date which has been given already in applicant's Information Disclosure Statement Form 1449 submission).

During the international phase of this application, applicant submitted a sworn affidavit from the editor of the BT Technology Journal which was accepted and referenced in the IPER dated 25 April 2001 and which the U.S. Patent and Trademark Office has acknowledged receiving in the Notice of Acceptance dated 10/01/2001. In any event, another copy of the IPER is attached hereto for the Examiner's convenience and reference is made to the fifth page of the IPER document where receipt and acceptance of the affidavit from the BT Technology Journal Editor is acknowledged.

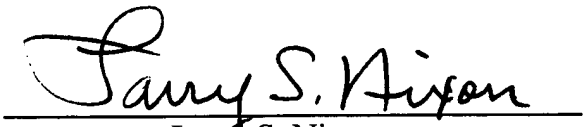
In addition, applicant attaches hereto a copy of that declaration and of the enclosures 1 and 2 referenced therein.

In view of the fact that Rix et al. is not "prior art", it is not believed necessary to discuss any further deficiencies in the outstanding grounds of rejection since they are all based primarily upon the assumption that Rix et al. is prior art.

Accordingly, this entire application is now believed to be in allowable condition and a formal Notice to that effect is respectfully solicited.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: 

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PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

LIDBETTER, T.
BT GROUP LEGAL SERVICES
Intellectual Property Department
Holborn Centre, 8th Floor
120 Holborn
LONDON EC1N 2TE
GRANDE BRETAGNE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	25.04.2001
Applicant's or agent's file reference A25651 WO	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/00171	24/01/2000	11/02/1999

Applicant
BRITISH TELECOMMUNICATIONS PUBLIC LIMITED...et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

   The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

   Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

   For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Eriksson, I Tel.+49 89 2399-2432

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
A25651 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/00171	24/01/2000	11/02/1999
International Patent Classification (IPC) or national classification and IPC H04N17/00		
Applicant BRITISH TELECOMMUNICATIONS PUBLIC LIMITED...et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
16/08/2000	25.04.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Moorhouse, D Telephone No. +49 89 2399 8631

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/00171

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,2,6-12,14	as originally filed			
13	as received on	05/02/2001	with letter of	30/01/2001
3-5	as received on	05/04/2001	with letter of	04/04/2001

Claims, No.:

1-20

Drawings, sheets:

1/3-3/3	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:
   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

Concerning Box V

The subject-matter of claims 1 to 20 meets the requirements set out in Article 33 PCT.

It is first noted that the claimed method and apparatus are clearly usable in the field of video communications, and thus are industrially applicable (Article 33 (4) PCT).

Novelty and inventive step (Articles 33 (2) and (3) PCT) are no longer at issue, as will be apparent from the following summary of the prior art disclosures on file.

BT Technology Journal, Vol. 17, No. 1 Is not part of the prior art, as it was first distributed to the public on 19/3/99. Although this is rather late for the distribution of a quarterly journal, relating to the first quarter of the year, there is on file an affidavit from the editor confirming the said distribution date, which is later than the claimed priority of 11/2/99. Its content is identical to at least the subject-matter of the independent claims on file.

DE-C-195 21 408 Discloses a method / apparatus according to which the highest frequencies present for certain spatial orientations are measured for the original and the distorted image. The reduction in these frequencies is taken as a measure of the quality of compression. As the Applicant submits, in Figure 7 of the present application, the lines forming the hatching pattern can be considerably blurred, without making the distinction between the hatching types (a "perceptually relevant"boundary) invisible. However, the DE publication would consider that there are great differences between the images in this case.

US-A-5 446 492 Discloses that both the first (source) and second (destination) image are input in parallel to a Sobel filter and a frame differencer. These units are followed by a spatial and a temporal statistical processor respectively. Statistics calculated include a standard deviation (spatial) and an RMS value (temporal) of a region of interest. Quality of the destination image is defined as the absolute value of the difference between 1 and the ratio of destination RMS to source RMS value. Therefore of little relevance to independent claims 1 and 12.

Signal Processing, Vol. 70, 1998 Discloses measurement of MPEG coded video quality. It is stated in connection with Figure 5, that errors occurring at sharp luminance transitions are of reduced perceptibility, and can thus be masked out by a mask function of value 0 at the edge, and linearly increasing to a maximum value at 5 pixels either side of the edge.

Concerning Box VII

The claims are not in the two-part form set out in Rule 6.3 (b) PCT.

effect or to obliterate detail, such as the facial features of a person whose identity it is desired to conceal.

If the requirements of a wide range of applications, from high definition television to video conferencing and virtual reality, are to be met, a more complex architecture has to be used.

Some existing visual models have an elementary emulation of perceptual characteristics, referred to herein as a "perceptual stage". Examples are found in the Karunasekera reference already discussed, and Lukas, X. J., and Budrikis, Z. L., *"Picture Quality Prediction Based on a Visual Model", IEEE Transactions on Communications, vol. com-30, No. 7, pp. 1679-1692 July 1982,* in which a simple perceptual stage is designed around the basic principle that large errors will dominate subjectivity. Other approaches have also been considered, such as a model of the temporal aggregation of errors described by Tan, K. T., Ghanbari, M. and Pearson, D. E., *"A video distortion meter", Informationstechnische Gesellschaft, Picture Coding Symposium, Berlin, September 1997.* However, none of these approaches addresses the relative importance of all errors present in the image.

For the purposes of the present specification, the "colour" of a pixel is defined as the proportions of the primary colours (red, green and blue) in the pixel. The "luminance" is the total intensity of the three primary colours. In particular, different shades on a grey scale are caused by variations in luminance.

According to a first aspect of the present invention, there is provided a method of measuring the differences between a first video signal and a second video signal, comprising the steps of:

analysing the information content of each video signal to identify the perceptually relevant boundaries of the video images depicted therein;

comparing the boundaries so defined in the first signal with those in the second signal; the comparison including determination of the extent to which the properties of the boundaries defined in the first image are preserved in the second image, and

generating an output indicative of the perceptual difference between the first and second signals.

According to a second aspect of the present invention, there is provided apparatus for measuring the differences between a first video signal and a second video signal, comprising:

analysis means for the information content of each video signal, arranged to identify the perceptually relevant boundaries of the video images depicted therein;

comparison means for comparing the boundaries so defined in the first signal with those in the second signal; the comparison including determination of the extent to which the properties of the boundaries defined in the first image are preserved in the second image,

and means for generating an output indicative of the perceptual difference between the first and second signals.

The boundaries between the main elements of an image may be identified by any measurable property used by the human perceptual system to distinguish between such elements. These may include, but are not limited to, colour, luminance, so-called "hard" edges (a narrow line of contrasting colour or luminance defining an outline or other boundary, such a line being identifiable in image analysis as a region of high spatial frequency), and others which will be discussed later.

The properties of the boundaries on which the comparison is based include the characteristics by which such boundaries are defined. In particular, if a boundary is defined by a given characteristic, and that characteristic is lost in the degraded image, the degree of perceived degradation of the image element is dependant on how perceptually significant the original boundary was. If the element defined by the boundary can nevertheless be identified in the degraded image by means of a boundary defined by another characteristic, the comparison also takes account of how perceptually significant such a replacement boundary is, and how closely its position corresponds with the original, lost, boundary.

The basis for the invention is that elements present in the image are not of equal importance. An error will be more perceptible if it disrupts the shape of one of the essential features of the image. For example, a distortion present on an edge in the middle of a textured region will be less perceptible than the same error on an independent edge. This is because an edge forming part of a texture carries less information than an independent edge, as described by Ran, X., and Favardin, N., *"A Perceptually Motivated Three-Component Image Model - Part II: Application to Image Compression", IEEE Transactions on Image Processing, Vol. 4, No. 4, pp. 713-724, April 1995.* If, however, a textured area defines a boundary, an error that changes the properties of the texture throughout the textured area can be as important as an error on an independent edge, if the error causes the textured characteristics of the

area to be lost. The present invention examines the cognitive relevance of each boundary, and the extent to which this relevance is preserved.

The process identifies the elements of greatest perceptual relevance, that is the boundaries between the principal elements of the image. Small variations in a property within the regions defined by the boundaries are of less relevance than errors that cause the boundary to change its shape.

Moreover, the process allows comparison of this information independently of how the principal elements of the images are identified. The human perceptual system can distinguish different regions of an image in many different ways. For example, the absence of a "hard edge" will create a greater perceptual degradation if the regions separated by that edge are of similar colour than it will if they are of contrasting colours, since the colour contrast will still allow a boundary to be perceived. The more abrupt the change, the greater the perceptual significance of the boundary.

By analysing the boundaries defined in the image, a number of further developments become possible.

The boundaries can be used as a frame of reference, by identifying the principal elements in each image and the differences in their relative positions. By using differences in relative position, as opposed to absolute position, perceptually unimportant differences in the images can be disregarded, as they do not affect the quality of the resulting image as perceived by the viewer. In particular, if one image is offset relative to another, there are many differences between individual pixels of one image and the corresponding pixels of the other, but these differences are not perceptually relevant provided that the boundaries are in the same relative positions. By referring to the principal boundaries of the image, rather than an absolute (pixel co-ordinate) frame of reference, any such offset can be compensated for.

The analysis may also include identification of perceptually significant image features, again identified by the shapes of the boundaries identified rather than how these boundaries are defined. The output indicative of the perceptual difference between the first and second signals can be weighted according to the perceptual significance of such image features. Significant features would include the various characteristics which make up a human face, in particular those which are significant in providing visual speech cues. Such features are of particular significance to the

much greater significance. Similarly, random dark specks would have a much greater effect on the legibility of Figure 6 than they would on Figure 4.

In more detail, the comparison process 33 consists of a number of individual elements. The first element identifies the closest match between the arrangements of the boundaries in the two images (34), and uses this to effect a bulk translation of one image with respect to the other (35) so that these boundaries correspond.

The next process 36 identifies features to which the human cognitive system is most sensitive, and weighting factors W are generated for such features. For example, it is possible to weight the cognitive relevance of critical image elements such as those responsible for visual speech cues, as it is known that certain facial features are principally responsible for visual speech cues. See for example Rosenblum, L.D., & Saldaña, H.M. (1996). *"An audiovisual test of kinematic primitives for visual speech perception".* (Journal of Experimental Psychology: Human Perception and Performance, vol 22, pages 318-331) and Jordan, T.R. & Thomas, S.M. (1998). *"Anatomically guided construction of point-light facial images".* (Technical report. Human Perception and Communication Research Group, University of Nottingham, Nottingham, U.K).

We can infer that a face is present using pattern recognition or by virtue of the nature of the service delivering the image.

The perceptual significance of each boundary in one image is then compared with the corresponding boundary (if any) in the other (37), and an output 38 generated according to the degree of difference in such perceptual significance and the weightings W previously determined. It should be noted that differences in how the boundary is defined (hard edge, colour difference, etc) do not necessarily affect the perceptual significance of the boundary, so all the boundaries, however defined, are compared together. Moreover, since the presence of a spurious boundary can be as perceptually significant as the absence of a real one, it is the absolute difference in perceptibility that is determined.

Note that degradation of the signal may have caused a boundary defined by, for example, an edge, to disappear, but the boundary may still be discernible because of some other difference such as colour, luminance or texture. The error image produced by established models (filtered and masked noise) provides an indication of the visible degradation of the image. The comparison process 37 includes a measure

CLAIMS

1. A method of measuring the differences between a first video signal (16) and a second video signal (16d), comprising the steps of:

analysing (31) the information content of each video signal to identify the perceptually relevant boundaries of the video images depicted therein;

comparing (33) the boundaries so defined in the first signal with those in the second signal; the comparison including determination of the extent to which the properties of the boundaries defined in the first image are preserved in the second image, and

generating an output (38) indicative of the perceptual difference between the first and second signals.

2. A method according to Claim 1, in which the information content is analysed for a plurality of boundary-identifying characteristics (32, 32d), and the properties of the boundaries on which the comparison (37) is based include the characteristics by which such boundaries are defined in each of the signals.

3 A method according to claim 2, wherein the characteristics include the presence of edges.

4 A method according to claim 2 or 3, wherein the characteristics include the presence of disparities between frames of the same signal.

5 A method according to claim 2, 3 or 4, wherein the characteristics include changes in at least one of the properties of: luminance, colour or texture.

6 A method according to any of claims 1 to 5, in which the comparison includes a comparison of the perceptibility of corresponding boundaries identified in the first and second signals.

7 A method according to any preceding claim, in which the comparison of the images includes the steps of

identification (34) of the principal elements in each image, and

compensation (35) for differences in the relative positions of the said principal elements.

8 A method according to any preceding claim, in which the analysis includes identification of perceptually significant image features, and the output (38) indicative of the perceptual difference between the first and second signals is weighted (36) according to the cognitive relevance of such image features.

9. A method according to claim 8, in which the perceptually significant image features are those characteristic of the human face.

10. A method according to claim 9, in which a weighting is applied to the output according to the significance of the feature in providing visual cues to speech.

11 A method according to claim 8, in which the perceptually significant image features are those by which individual text characters are distinguished.

12 Apparatus for measuring the differences between a first video signal (16) and a second video signal (16d), comprising:

analysis means (31) for the information content of each video signal to identify the perceptually relevant boundaries of the video images depicted therein;

comparison means (33) for comparing the boundaries so defined in the first signal (16) with those in the second signal (16d); the comparison including determination of the extent to which the properties of the boundaries defined in the first image are preserved in the second image,

and means for generating an output (38) indicative of the perceptual difference between the first and second signals (16, 16d).

13. Apparatus according to Claim 12, wherein the analysis means (31) is arranged to analyse the information content in the signals (16, 16d) for a plurality of boundary-identifying characteristics (32, 32d), and the comparison means (33) is

arranged to compare the characteristics by which such boundaries are defined in each of the signals.

14 Apparatus according to claim 13, wherein the analysis means (31) includes means to identify the presence of edges.

15. Apparatus according to claim 13 or 14, wherein the analysis means (33) includes means to identify the presence of disparities between frames of the same signal.

16. Apparatus according to claim 13, 14 or 15, wherein the analysis means (33) includes means to identify differences in at least one of the properties of: luminance, colour or texture.

17 Apparatus according to any of claims 12 to 16, in which the comparison means (33) includes means for determining the perceptibility of the boundaries identified in the first and second signals.

18 Apparatus according to any of claims 12 to 17, in which the comparison means (33) includes image matching means (34) for identification of the principal elements in each image and translation means (35) for effecting translation of one image (16d) to compensate for differences in the relative positions of such elements in the first and second images.

19. Apparatus according to any of claims 12 to 18, in which the comparison means (33) includes weighting means (36) for identifying perceptually significant image features in the components (32, 32d), and weighting the output (38) according to the cognitive relevance of such image features.

20. Apparatus according to any of claims 12 to 19, further comprising visual stage means (11,12,13,14,15) for processing original input signals (11) to emulate the response of the human visual system, to generate modified input signals (16, 16d) for input to the analysis means (31).

This is a sworn statement by Andrew Malcolm Jell of Lernout & Hauspie Ltd, B1, Adastral Park, Martlesham Heath, Ipswich, Suffolk, IP5 3RE.

I am the Editor of the BT Technology Journal (BTTJ), which is published by Lernout & Hauspie. I have been the Editor since 1986.

I received the paper "Models of Human Perception" by Anthony Rix on 9 December 1998 on a floppy disk given to me by John Seton who was co-ordinating all the papers for Vol 17 No 1 of the BTTJ. The paper was then edited and formatted to the Journal house style.

I forwarded the paper in electronic format (file name 'Moh.zip') to our in-house printers on 13 February 1999, as shown in the covering email, a printout of which is at enclosure 1. The reason for the delay between the receipt of Anthony Rix's paper and sending the formatted version to the printers was because many of the other papers were received late (the last paper not being received until 25 January 1999); all papers were then paginated and sent to the printers at the same time.

Distribution of the printed periodical is controlled by myself. Volume 17 No 1, which has the cover date of January 1999, in which the paper by Mr Rix appears, was in fact distributed on 19 March 1999. No copies of Anthony Rix's paper were released by me to anyone else prior to 19 March 1999.

Attached as enclosure 2 is a printout of an email I sent to our in-house printers on 23 March 1999, confirming receipt of the copies of the printed Volume 17 No 1 of the BTTJ on Friday 19 March 1999.

I attach printouts of the electronic mail cover sheet transmitting Mr Rix's paper from myself to the printers and the electronic mail sent by myself to the printers confirming receipt of the printed volume on 19 March 1999.

Sworn before me.....
at 41 Berners Square
Marlesham Heath
a Solicitor empowered to swear oaths

this 29 day of November 2000.

DERMOTT THOMAS
BARKER GOSELEE

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To: "'maria.kucharz@heitmann.de'" <maria.kucharz@heitmann.de>
From: Andrew Jell <andrewj@ipswich.sac.co.uk>
Subject: BTTJ File MOH
Cc:
Bcc:

Maria

Please find attached MOH file in ZIP format

Andrew

This is enclosure 1 referred to in the affadavit of Andrew Malcolm Jell sworn before me this 29th November 2000

To: <christoph.schwenke@heitmann.de>
From: Andrew Jell <andrewj@ipswich.sac.co.uk>
Subject: BTTJ
Cc:
Bcc:

Chris

Thanks for the copies which arrived on Friday. They look good.

If you no longer require the FrameMaker program disks I sent you, could you package them up and send them back in the near future. Thanks.

Andrew

This is enclosure 2
referred to in the
affadavit of Andrew
Malcolm Jell sworn
before me this 29th
November 2000